U.S. DEPARTMENT OF COMMERCE

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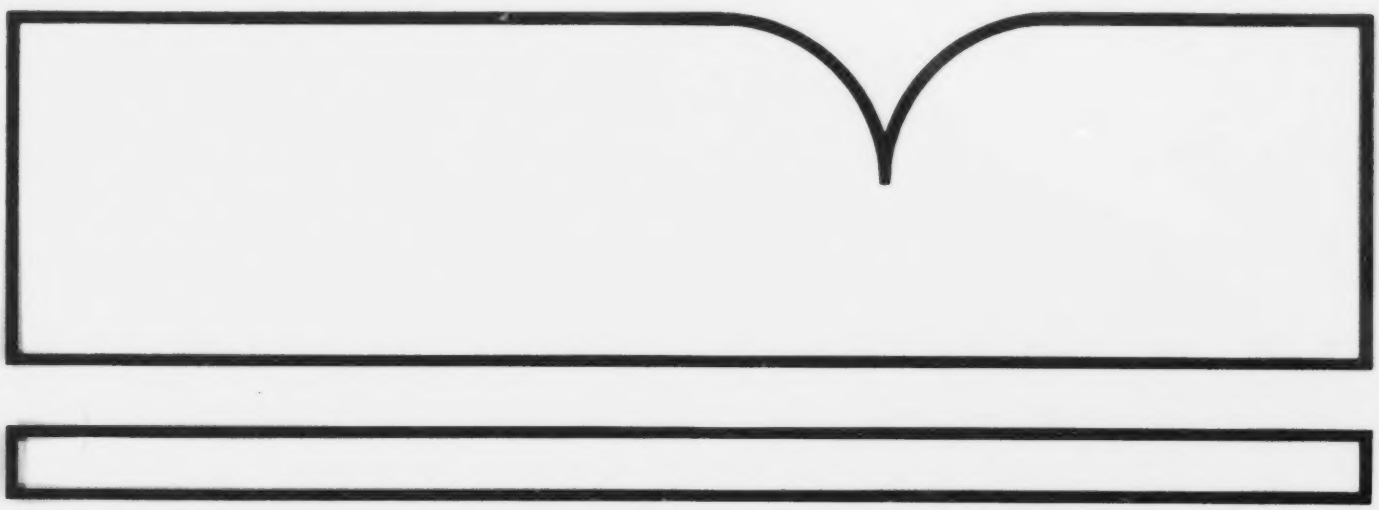
Air Pollution Emissions Inventory Systems
Appendix A: Emissions Inventory in Belgium

NATO Committee on the Challenges of Modern Society, Brussels (Belgium)

Jul 79



U.S. Department of Commerce
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NATO CDSM
OTAN CCMS

COMMITTEE ON
THE CHALLENGES OF
MODERN SOCIETY

AIR POLLUTION EMISSIONS INVENTORY SYSTEMS APPENDIX A EMISSIONS INVENTORY IN BELGIUM

Number 104

NORTH ATLANTIC TREATY ORGANIZATION

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16. ABSTRACT

This document is an appendix to report number 104; it gives a general overview of emissions inventory systems as well as methods currently applied in Belgium.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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AIR POLLUTION EMISSIONS INVENTORY SYSTEMS

A Report of the NATO/CCMS Pilot Study
on Air Pollution Assessment Methodology and Modeling

No. 104, APPENDIX A

Air Pollution Emissions Inventory Systems used in Belgium

COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY
NORTH ATLANTIC TREATY ORGANIZATION
(July 1979)

Preface

The North Atlantic Treaty Organization (NATO) established the "Committee on the Challenges of Modern Society" (CCMS) at the November 1969 meeting of the North Atlantic Council.

The CCMS was charged with developing meaningful environmental and social programs that complement other international programs, and with showing leadership, first, in solution of existing problems and, second, in development of long-range goals for environmental protection in the NATO sphere of influence and in other countries as well. A first Pilot Study on Air Pollution was initiated by the CCMS at its inaugural meeting in December 1969. The United States (Environmental Protection Agency) has been the pilot nation with the Federal Republic of Germany (Federal Ministry of the Interior) and Turkey (Scientific and Technical Research Council) as copilot-nations.

The Pilot Study on Air Pollution was an action program designed to demonstrate and encourage the utilization of existing knowledge for the development of air quality management programs. It entailed the demonstration of a system approach to air quality management. Case studies have been carried out in Ankara, Turkey; Frankfurt, Federal Republic of Germany; St. Louis, U. S.; Oslo, Norway; South Holland Region, The Netherlands (NATO/CCMS Report No. 6, Appendices A - E).

The results of the pilot study are documented in NATO/CCMS Report No. 6 (Revised) "Guidelines to Assessment of Air Quality" of October 1972 and in NATO/CCMS Report No. 33 (Final Report) containing 15 recommendations as well as in several other documents, listed as Annex II to this document.

Starting from three of the above recommendations (VI, VII and XIV) the Federal Republic of Germany proposed to initiate a new Pilot Study on Air Pollution Assessment Methodology and Modeling at the CCMS Plenary Session on October 22 and 23, 1974.

These NATO/CCMS Recommendations are:

RECOMMENDATION VI

Member nations will co-operate to develop standardized methods for emissions data storage and retrieval to support requirements in the conduct of national air quality management programs. The US National Emission Data System (NEDS) might serve as a model for a common international system.

RECOMMENDATION VII

Member nations will co-operate to develop standardized techniques for projecting emissions and predicting future ambient air quality.

RECOMMENDATION XIV

Member nations agree the CCMS modeling activity has shown that there is a widespread need for further international co-operation to accomplish the following tasks:

Bring together model developers and air quality managers for exchange of ideas, discussion of users' needs and demonstration of modeling techniques.

Standardize modeling techniques for specific air quality management applications and consider how computerized models might be made available for all users.

Continue to review on-going air quality assessment studies.

In spring 1975 the North Atlantic Council approved the German proposal. The pilot study work started with the Federal Republic of Germany (Federal Ministry of the Interior) as pilot nation and the United States of America (Environmental Protection Agency) and Belgium (Service du Premier Ministre) as co-pilot nations:
A Working Group and two Panels were established with the following functions:

Assessment Methodology Panel

- Pursue and carry out Recommendations VI and VII
- Continue to review present and future assessment studies with respect to the application of assessment methodology.

Modeling Panel

- Develop standardized models for various air quality management applications.
- Develop programs to improve modeler/user communications in conjunction with the Assessment Methodology Panel and the Working Group.
- Continue as an information forum on new modeling concepts and techniques, organizing once a year international technical meetings on air pollution modeling and its application.

In addition the Working Group established an Ad-Hoc Group on Air Quality Management Systems to revise and update the NATO/CCMS Report No. 6 (Revised) 1972 by preparing a new document on "Guidelines to Air Quality Management Systems".

Another Ad-Hoc Group was set up for compiling a Glossary of Terms frequently used in assessment methodology, modeling and air quality management systems.

As an outcome of this Pilot Study on Air Pollution Assessment Methodology and Modeling the following NATO/CCMS documents are published (see also Annex III):

Air Quality Management System

- Guidelines to Air Quality Management System.

Assessment Methodology

- Air Pollution Emissions Inventory Systems
- Air Pollution Emissions Projecting

Air Pollution Modeling

- Introduction to Air Quality Modeling
- Uses and Needs for Air Quality Modeling
- Bibliography on Grey Literature on Air Quality Modeling, Part I (Applied Models)
- Bibliography on Grey Literature on Air Quality Modeling, Part II (New Modeling Techniques)
- Practical Demonstration of Multiple Source Urban Air Quality Modeling (Gaussian Plume)
- Fundamentals for the Applications of a Gaussian Plume Model

Other Publications

- Glossary of Terms
- Proceedings of the 6th to 9th International Technical Meetings on Air Pollution Modeling and its Application
  (6th Meeting, 24. - 26. Sept. 1975, Frankfurt/Main, Germany)
  (7th Meeting, 7. - 10. Sept. 1976, Airlie House, USA)
  (8th Meeting, 20. - 23. Sept. 1977, Louvain-la-Neuve, Belgium)
  (9th Meeting, 29. - 31. Aug. 1978, Toronto, Canada).

The chairman of the Working Group wishes to acknowledge the scientists participating from pilot, copilot, and observer countries, and the many other persons, who assisted in the preparation of this document.

The panel, which performed diligently throughout the course of this effort, receives the highest praise. The panel members were:

Federal Republic of Germany - Pilot Country

F. Gerold
H. Meinl
K. E. Joerss

Belgium - Copilot Country

R. Dams
C. de Wispelaere

United States of America - Copilot Country

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J. R. Hammerle
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Canada - Observer

P. J. Choquette

France - Observer

W. Challemel du Rozier

Norway - Observer

O. I. Skogvold

The Netherlands - Oberserver

L. H. J. Wachters.

The addresses of the panel members are listed in Annex I.

Full recognition is given to each panel member for carrying out and coordinating review and other activities related to the development of this document in his respective country and to Ms. C. Morawa of the Federal Environmental Office, Germany for her effort in coordinating and organising and for editorial work.

For the Working Group,
Erich Weber, Chairman.

The present document is an appendix to the NATO/CCMS document

AIR POLLUTION EMISSIONS INVENTORY SYSTEMS

No. 104, October 1978

which gives a general overview of the matter of emissions inventory systems as well as of the methods currently applied in BELGIUM, CANADA, the FEDERAL REPUBLIC OF GERMANY, The NETHERLANDS, NORWAY and the UNITED STATES OF AMERICA.

It contains documentations of air pollution emissions inventory systems currently used in

Belgium	Appendix A
Canada	Appendix B
Germany, F. R.	Appendix C
The Netherland	Appendix D
Norway	Appendix E
United States	Appendix F

Each appendix is bound as a separate volume

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Part I:

AIR POLLUTION EMISSIONS INVENTORY TECHNIQUES

1. General Introduction

Because in the framework of a national air pollution program the need for emission measurement and inventorying was realised, in 1975 the Interministerial Commission for Science Policy decided to set up a research and development program on emissions inventory techniques in Belgium. The primary purposes of this program are the study of the methodology of emissions inventorying, the validation of dispersion models and the assessment of the economical impacts of a control strategy. A number of educational institutions have the responsibility for the collection of the emission data and for investigations concerning source testing. The emission data of the inventory, the immission data from the air monitoring system, and the meteorological data are all assembled in a data bank operated by an institution from the national government. The same institution operates the data processing in close cooperation with the units responsible for the data collection. Development and validation of air pollution dispersion models by means of the data is again the duty of certain educational and research institutions. The present paper only deals briefly with the methodology, applied in the data collection up to the beginning of 1977.

For this research program three test areas have been chosen, namely: Brussels which is the capital and a large city surrounded by industrial activities; the city of Gent with an elongated rectangle along the Gent-Terneuzen canal, in which a large variety of industries is situated; finally the city of Liege with its heavy industrialized surroudings. In the test areas Gent and Liege the industrial emissions as well as emissions caused by transportation and domestic heating are under investigation. The test area Brussels will only by studied from the viewpoint of transportation. The three

test areas, each with a surface of nearly 100 km² have been divided in 1 kilometer squares for storage, in order to develop gridded area source data.

Owing to the limitation of resources in the areas Liege and Brussels only the methodology of data collection by means of questionnaires, calculation, application of emission factors, source testing and the use of statistical data is being studied. In the test area of Gent a complete emissions inventory will however be assembled for the year 1978. A number of pollutants have been chosen as primary study objects. These are sulfur oxides, nitrogen oxides, carbon monoxide, gaseous hydrocarbons, total mass of solid particles and a number of components from the dust such as lead, cadmium, manganese, vanadium, fluorine, carcinogenic polycyclic hydrocarbons and asbestos.

For the collection of emission data on mobile sources and home heating a collective approach is applied. The industrial point and area sources are however individually recorded. The methodology used in the latter approach is based on the one developed by the TNO in the Netherlands (see paper Netherlands) but has been adapted to the local situation.

In the program a large effort is spent at the experimental determination of emission factors for point and transportation sources. As a consequence of this priority, the majority of the man power is needed for source testing in industrial facilities and on exhausts of vehicles. Also the modern equipment for continuous emission monitoring in industrial sources is being tested in the framework of the same program.

The study has only been started at the end of 1975, and should be finished at the end of 1980. At that time, the methodology should be known sufficiently in order to start a more extensive emissions inventorying programm for the entire country. The necessary decisions for such a country - wide program have however not yet been taken, neither have the responsibilities been assigned.

2. Data Collection

2.1 Emissions caused by transportation

The emission data from mobile sources will be recorded by a collective approach. The methodology is now being developed as follows. First the test areas are subdivided in small sub-areas (equal or less than 1 km^2) in which only one type of surface-traffic and only one type of line-traffic exists. Three types of surface-traffic and four types of line-traffic are distinguished. Also five types of vehicles are considered (gasoline or fuel oil consuming cars or utility-vans and varicus other vehicles). The emissions per unit distance covered ($g.km^{-1}$) and per unit of time for these different types of vehicles are calculated on the basis of measurements during the typical European driving cycle of short duration. The mean speed of this driving cycle is 19 km. h^{-1} and this driving mode is therefore called DM 19. For this driving mode the emissions are known from numerous tests for homologation. Six other driving modes (DM 5, DM 10, DM 25, DM 49, DM 63 and DM 84) are being considered. The emissions during these driving modes are obtained from extensive measurements on a gasoline and a fuel oil using car in the weight range from 850 to 1250 kg, which represents more than 80 % of the Belgian car-park. Also the increace of the emissions as a

function of mileage covered by the vehicles is being studied using the same cars. In a further stage of the study similar simulation will be performed for heavy duty vehicles (above 10 tons) and for all driving modes.

Also the variation of the traffic density will be studied and techniques are being tested to determine the number of mobile sources that at a certain time in a certain area can be ascribed to each type of traffic. Official data from traffic counts, aerial photography and counting by volunteers are being investigated for this purpose. For line-traffic also certain correlations appear to exist between mean speed or driving mode and traffic density. These correlations depend however on a number of parameters, such as number of lines, presence of traffic lights, speed limitations, etc.

Finally also the emissions of railway engines, boats with diesel and aircraft landing or take off must be recorded.

The contributions of all vehicle classes and traffic types in each 1 km^2 will be summed and given as a function of time.

The emissions of mobile sources will also be estimated roughly on the basis of fuel consumption in the area. This approach will obviously give only a rough estimate of the emissions in the whole test area, owing to the relatively small size of the test areas (100 km^2).

Interest is focussed towards the most important pollution gases, lead and vanadium.

2.2 Emissions caused by space heating and other minor sources

An inventory is being made of the combustion sources for heating purposes by collective inventorying on the basis of the latest data on population density and housing. For each 1 km² grid from the test area the stationary combustion sources are subdivided as follows:

a) Individual central heating facility using:
   - coals or cokes
   - natural gas
   - butane or propane gas
   - electricity
   - fuel oil
   - other fuels

b) Commercial central heating facility with same fuel types

c) Fire heating with same fuel types.

Statistical data are obtained from the Ministry for Economic Affairs and from the Belgian National Institute for Statistics. Since new population statistics are being made for the area in the second half of 1977, these data can be considered as quite representative for 1978. Not only data on population density and on the number of houses, but also on the type of heating facility and the year of construction of each house or building are available per counting sector. The contribution of each counting sector to each 1 km² grid of the test area is calculated.

The yearly consumption of the different fuels will be obtained in several ways. For the coal consumption an oral investigation (± 200 houses) was performed. From a similar oral investigation by means of a questionnaire it appeared that many

inhabitants cannot give an accurate estimation of their yearly consumption of gasoil or other fuel oil. Therefore use is made of the statistics available from fuel oil distributing companies. These companies have records of the consumption of their clients as a function of the outdoor temperature difference to 18° or 20 °C. The accuracy of this approach will be tested by means of a more extensive written investigation, using a very simple questionnaire in a representative part of the test area. A positive response of around 40 % is expected. The daily variations of the consumptions, as a function of outdoor temperature will also be obtained from data available from the city gas-distributing company.

For the calculation of the emissions of the pollution gases and total dust, use will be made of literature data. In fact an extensive compilation was made of all available emission data for combustion of fossil fuels in small stationary sources. A limited number of source tests has been performed for some pollutants such as fluorine, cadmium, vanadium and manganese, owing to the scarcity of emission data for these elements in literature. The application of the emission factors to the statistical data is however still difficult, due to the variety in burner-types, capacity, heating habits, fuels used, etc. This variation has in fact a large influence on the emission factors, and obviously all the necessary parameters are not known for the individual installation, since a collective approach is applied.

The amounts and types of fuel consumed for heating of the greenhouses that are extensively used for horticulture in the area are very accurately known by the Ministry for Economic Affairs. A number of representative heating facilities

in use for this purpose will be visited in order to estimate the emissions as accurately as possible. In fact the emission factors vary drastically in function of the capacity and the type of burner used.

2.3 Emissions caused by industrial facilities

The collection of data on all industrial facilities with specific emissions or with a boiler of more than 100 m² heating surface is performed by the individual approach. A heating surface of 100 m² is approximately equivalent to a capacity of 2×10^6 kcal. h^{-1}. This individual recording of the emission data from an industrial or other large emission point or area can be considered as the result of three distinct steps.

The first data to be collected result from an introductory questionnaire (1). It provides general information about the company or the plant (part A), qualitative emission data (part B) and information on the facilities or process units (part C 1). Part B emphasizes the following components: carbon monoxide, sulfur dioxide, sulfur trioxide, sulfuric acid, nitrogen monoxide, nitrogen dioxide, hydrocarbons and solid particles. The formulation of this first questionnaire is based upon the directions of the "Centraal Technisch Instituut" (TNO) from the Netherlands. The notation "Entry" requires a code number which indicates whether the information is new, replaces earlier information or is to be deleted. On form B the most important effect of the emitted substance must be filled by the recording person. This can be soiling, toxic, smelling or etching. By means of form C_1 as complete a block flow diagram of the entire plant as possible and detailed information on the different facilites in the plant are requested.

More elaborate information is to be collected personally by the investigators (questionnaire II). They have at their disposal the directories of the TNO and an appropriate classification code in order to acquire extensive information on facilities (part C_2), sources (part D) and precise data on emissions (part E).

The block flow diagram, requested on form C_1, consists of a number of facilities or independent process units. For each facility a form C_2 must be filled. Here all apparatus that contribute to the emissions in some way, that can be measured, calculated or estimated, must be listed and numbered from 01 up. From each apparatus the geographical situation must only be given in terms of the 1 km² grid in which it is situated. Also the name of the apparatus should be given in order to facilitate later communication with the personnel at the plant. If some of the apparatus emit the same pollutants, simultaneously and if they are located in the same grid they obtain the same number, with a list of the included apparatus. The nominal capacity of each apparatus is one of the requested data. When a group of apparatus is summarized under one number, obviously the total capacity and the appropriate units used must be given. Preference is given to some of the following units: g, l, $g.h^{-1}$, $l.h^{-1}$ and W. As a first step towards the identity of the emissions, here the substances handled in each apparatus are requested. For power producing installations, the amount, the nature, the ash content and the sulfur content of the fuel is important information.

On form D all information concerning the sources themselves must be given. The sources are to be numbered consecutively together with the number of the facility-apparatus to which

they belong. If the source emits pollutants originating from several apparatus, it obtains only the number of the facility or process unit. If a source is so large that it falls in several grids, it can be separated and considered as several sources each with their own number and specifications. Also that current name of the source is requested. The sources are divided in four types each with their code number. These are stack with vertical exhaust, stack without vertical exhaust, other emissions out of the apparatus and finally emissions out of buildings. Also from the sources the coordinates are given, with an accuracy of 1 m for important sources, for less intense source an accuracy of 10 m is sufficient. For surface sources the coordinates of the center are given. Geodetic and geometric height and the diameter of the source are obviously important parameters for dispersion calculations.

Finally a special form E must be filled for each pollutant per source and per series of periodically encountered emissions. The physical emission forms have been divided in 6 types (code B). These are gases without air or other components naturally occuring in air, gases mixed with air or other components naturally occuring in air, dust with particle size smaller than 10 µm, dust with particle size larger than 10 µm dust with unknown particle size, liquid drops, aerosols or mist. The mass-flow of the pollutant at maximum capacity is required. If the maximum or the mean mass-flow are not known it must be measured or calculated using AP-42 emission factors. The maximum volume must be given in $m^3.h^{-1}$. If possible the temperature at the outlet in the open air should be given. This temperature must often be calculated. Code C determines whether the mass-flow was measured by the plant itself, by the inventorying team or calculated.

The qualification (code D) asks for an indication of the accuracy of the data. These codes can be: estimation, calculation, rough measurement, accurate measurement, regular mea-

urement or continuous registration. Under operating modus should be given whether the installation is being started up, normally operating, etc.

The frequency, the length and the time of the periodical emissions must be defined per year, month, week, day and hour. Of course it must also be identified for which periods and time the emission data are pertinent. Also programmed periods of inactivity must be filled. Finally some data on the type, efficiency, control and costs of gas cleaning must be given.

Afterwards and as a third step in the data collection one can decide upon an experimental evaluation of the emissions. As a rule, emission factors from the EPA document AP 42 will be applied. Source testing will however be performed for important or not yet investigated plants, especially for those types of plants where emissions information is scarce. Such tests, up to the determination of emission factors, will certainly be performed at several iron and steel mills, a cement manufacturing plant, a power plant, a petroleum refinery and in the non-ferrous metallurgy. These tests include solid particle sampling, followed by chemical analysis of the particulates as a function of particle size by means of activation analysis, atomic absorption and X-ray fluorescence.

Emphasis is put on the following elements: lead, cadmium, fluorine, manganese and vanadium. The emissions of these elements are calculated as emission factors, referring to their concentrations in the raw materials. Also the mass-flow of several gaseous pollutants is measured and if possible monitored during a sufficiently long time to allow interpretation of the data in terms of emission factors.

The data are compiled in six data files, respectively for the companies, for the substance, for the installations, for the

apparatus, for the sources, for the pollutants. These files contain the nearly permanent data for the present installations and sources, from which, for a given capacity, the amount of pollutant emitted per unit of time can be calculated.

EMISSION REGISTRATION - Area : Industrial sources

QUESTIONNAIRE : FORM A - PLANT INFORMATION

DO NOT FILL THIS COLUMN

Name of the Company :

Plant Address :
street :
Nr. :
city :
postal code :

Card identification number : 001

Plant number :

Date :

Coordinates of Geographical position :

Section of Industrial activity (for example :chemical)

specify :

Entry :

Labor force : persons
process : persons
administration : persons

Name of responsable person :

Person to contact about this form :

position :
Tel. nr. :

QUESTIONNAIRE - FORM B :
SUBSTANCES INFORMATION

DO NOT FILL THIS COLUMN

Raw materials used Amount (tons/y)

Card identification number : 002

Entry :

Products Amounts (tons/y)

(give as recent data as possible, give the year to which the data refer :)

Substances which may be emitted in the air :

Most prominant substances	Emitted	Substance	Effect
CO			
SO_2			
SO_3 - H_2SO_4			
NO			
NO_2			
H.C. aliphatic			
aromatic			
unsaturated			
other			
Particulate matter			

Other substances :

QUESTIONNAIRE - FORM C_1 - FACILITIES INFORMATION

DO NOT FILL THIS COLUMN

Give a complete Block Flow Diagram of every Plant, where it is subdivided in independent facilities or process units

Card identification number : 003

Entry :

Specifiy clearly and in detail the nature of each of the facilities present in the flow diagram
Take into account :

Storage and handling
- raw materials
- fuels

Process units
Energy providing units
Storage and handling of products

Give also with each facility the emission sources

Facility n° :

QUESTIONNAIRE C_2

Apparatus and facilities information

Entry :
Plant :

Card identif. number : 003
Plant activity :

Recording person :
Year :
Number of plant :

Facility :
Name :
Geographical situation :

N° :
Capacity (units) :

Number :

Substances :

Apparatus	Name	N°	Capacity (units)	Geographical situation	Substances	Remarks

QUESTIONNAIRE - FORM D

Sources information

Entry :

Plant :

Card identification number : 004

Plant activity :

Recording person :

Year :

Number of plant :

Source n°	Facility apparatus n°	Name of the source	Source type (code A)	Geographical situation	Geod. height	Geom. height	Equiv. Ø (m)	Substances emitted

QUESTIONNAIRE - FORM E

Emissions Information

Entry :	Card identification	Recording person :
Plant :	number : 005	Year :
	Plant activity :	Plant number :

Facility number :
Apparatus number :
Source number :
Substance :
Emission form (code B) :
mass-flow ($mg.h^{-1}$) :
volume-flow ($m^3.h^{-1}$) :
temperature (° K) :
Origin (code C) :
Qualification (code D) :
Operating modus :
Capacity :
Frequency value :
unit :
Duration value :
unit :
Time-period : months
days
hours
Period considered :
Periods of programmed inactivity :
Gas cleaning device : type
efficiency (%)
control equipment
cost

ADDENDUM 2 - RESOURCES

The resources for the study of the methodology of emission inventorying and source testing in the three test areas can at present only be estimated very roughly since the project has only recently started. The program is intended to run for 5 years and the following manpower should be used during this period :

1) Initial setting up of the system :
   2 man-years (acad.)
2) Collection of the Emission Data :
   Industrial point sources : 12 man-years (acad.)
   5 man-years (non-acad.)
   Home heating and minor industrial sources : 8 man-years (acad.)
   Mobile sources : 3 man-years (acad.)
   3 man-years (non-acad.)
3) Methodology of Emission Measurements and Experimental Measurements
   Industrial point sources : 15 man-years (acad.)
   15 man-years (non-acad.)
   Mobile sources : 7 man-years (acad.)
   7 man-years (non-acad.)

P.S. acad. = having an academic degree (University graduated)
non-acad. = not having an academic degree.

The test program is now performed by personnel belonging to universities and other educational or research institutions.

Part II:

EMISSIONS INVENTORY DATA HANDLING,

- AIR QUALITY DATA BANK -

General scope

One of the major objectives of the National Air Pollution Research and Development Program is the creation of a National Air Quality Data Bank System which is to gather every significant data allowing the Belgian authorities to undertake an appropriate environmental policy, more specifically in the field of air pollution.

The Data Bank will contain five main classes of information, emission data, emission measurements, meteorological data, data pertaining to the transfer of pollutants across the ecological chains, and finally legal aspects of the struggle against air pollution.

This document will restrict itself to a general description of the emission data handling system.

Two categories of emission sources have been defined, namely point sources represented by the industrial sources and area sources mostly represented by space heating, traffic and other minor sources.

The inventory data is transmitted to the Data Bank on special data sheets whose content is then stored on punched cards. These cards are then inputted to the computer. The configuration used is a SIEMENS 7738 with 1024 Kbytes memory, to which we are connected via a video terminal coupled to a hardcopy imit.

In the near future, it will be extended to a heavy terminal composed of a card reader, two printers, two videos and one programmable unit devoted to the production of graphics. The transmission speed is 2400 bands. This terminal will be located at the National Data Processing Center (N.D.P.C.) in the Institute of Hygiene and Epidemiology. The central processing unit is situated at the Ministry of Public Works.

1. Industrial Emissions Data Base

1.1. Generalities

The methodology used for the inventory of industrial emissions has been derived from the directives of the "Centraal Technisch Instituut" (TNO) from the Netherlands. It has been adapted to the local conditions met and to the requirements of the Data Base users (principally those responsible for the mathematical models of air pollution). Seven groups of information have been defined, namely:

COMPANY or PLANT, SUBSTANCES, FACILITIES, APPARATUS, SOURCES, EMISSIONS and POLLUTANTS.

They have been organised in a hierarchical structure having PLANT as root segment (fig 1). The relations between groups are implemented by means of pointers located in the prefix of each record in the data base, and are updated by the system when necessary.

For instance the arrow between the groups FACILITIES and SUBSTANCES indicates that substances are used or procduced by facilities, the arrow linking the groups EMISSIONS and SOURCES indicates that an emission takes place through a well defined source, the arrow linking the groups APPARATUS and EMISSIONS that an emission is produced when operating an apparatus which in turn is a part of a facility (arrow between FACILITIES and APPARATUS), etc.

Each group is a set of information segments corresponding to records on a disk file. The root segments are accessed through an ISAM index file whose keys are the identification numbers allocated to each plant (fig. 2).

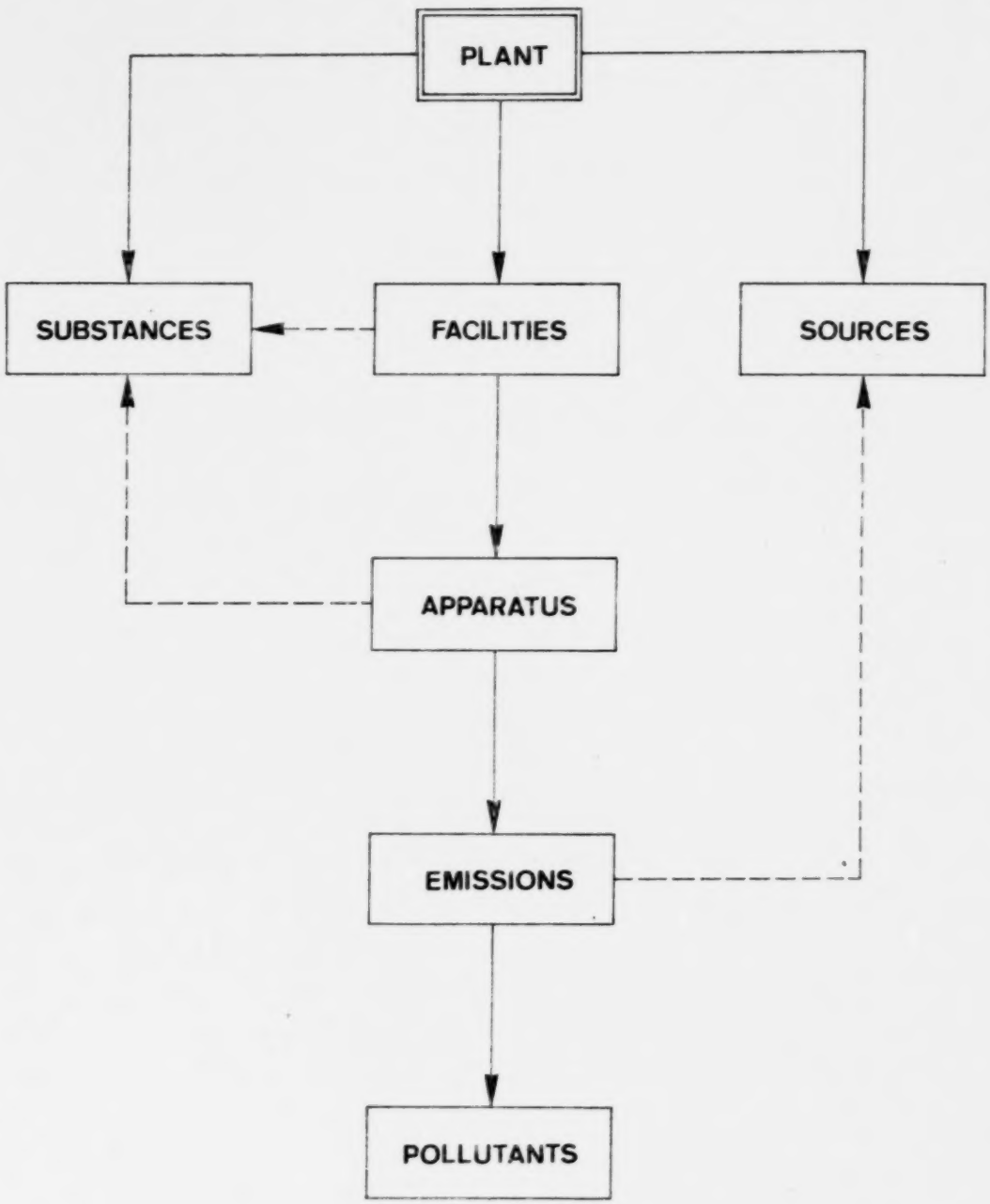

Figure 1 - Logical structure of the industrial emissions data base.

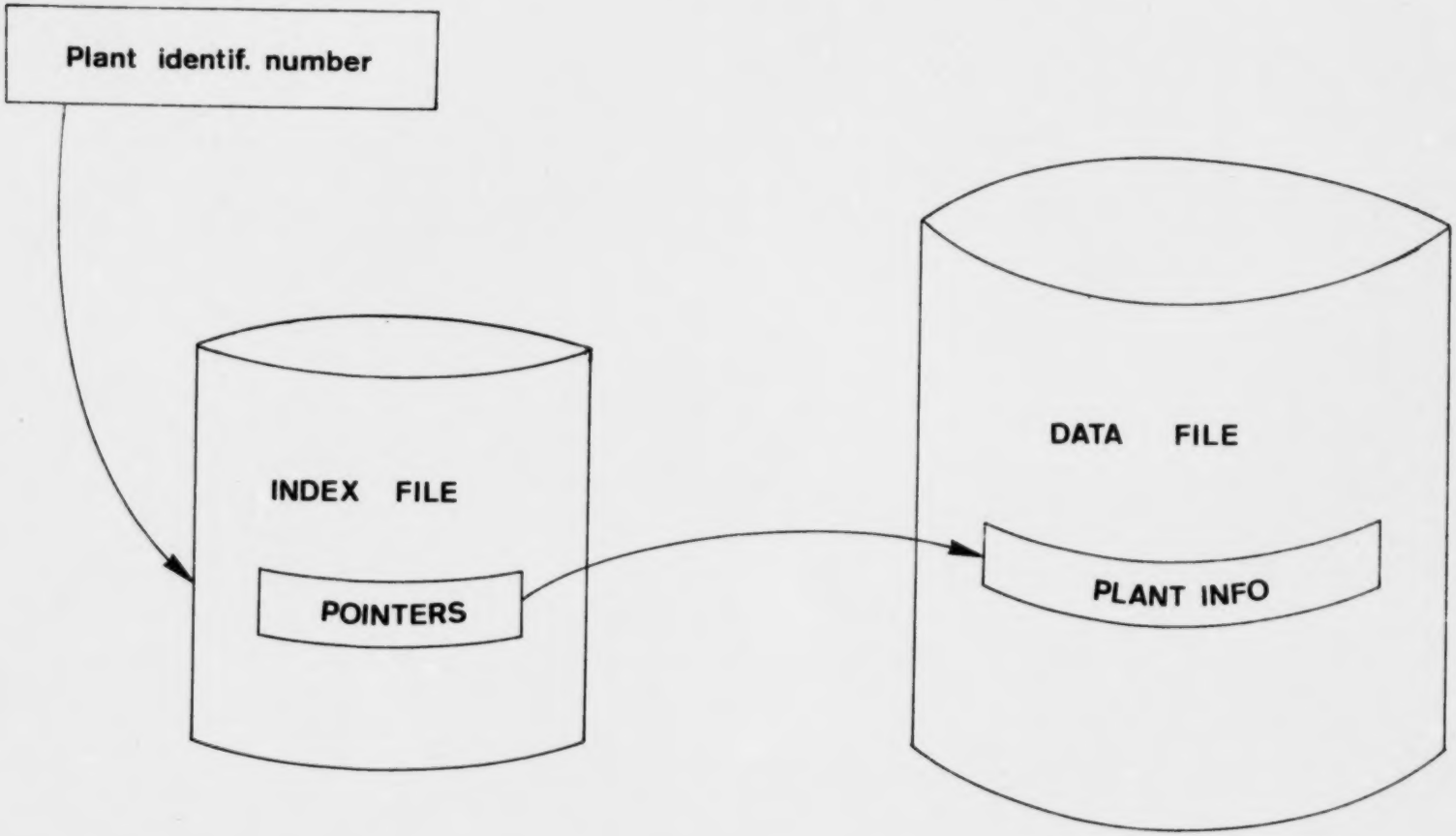

Figure 2 - Schema of acces to the industrial emissions data base.

A second file contains the seven groups of information associated to the plant. Each record of this data file is made of two distinct parts: a prefix containing the set of pointers according to the information structure, the data of insertion or last modification and a validation index (actually not yet used), and a second part containing the data.

Each group of information and so each record has its own set of keys to identify it:

- plant identification number (plant);
- plant identification number and facility identification number (facilities);
- plant identification number, facility identification number and apparatus identification number (apparatus);
- plant identification number and source identification number (sources);
- plant identification number, facility identification number, apparatus identification number and emission identification number (emissions);
- plant identification number, facility identification number, apparatus identification number, emission identification number and pollutant identification code (pollutants).

1.2. Data base description

In order to have a system as general as possible which should not depend on slight modifications in the data base structure, a program named EMINDM has been devised which uses directives to create a data base description file. This file is to be read by every program which needs to know the data base structure.

1.3. Updating the data base

Updating is performed with a set of three routines (fig. 3):

- the routine EMINDI reads the punched cards or an input disk file or directly from the terminal, and makes the following data verifications:

  . the card code must lie between 1 and 7
  . the mutation code must be 1, 2 or 3
  . the mode of representation of the data in each zone must correspond to the data base description (i. e. characters are invalid in a numeric zone)
  . the year found on the card must correspond to the year of the data base being updated: there is one data base for each year and only one data base can be open at the same time. The accepted data are stored in a workfile named EMINDA while rejections are posted on an errorfile EMINDE together with the cause of error.

- the routine EMINDR takes back the data from the file EMINDA and transfers them in the data base, updating the index when necessary. The mutation code is taken into account to decide which kind of operation should be performed (addition, modification, deletion). Rejected data are posted on the error file EMINDE together with the cause of rejection. Amongst the most common causes of error, one may quote the following:

  . a new segment already exists in the data base
  . a segment to be modified or deleted does not exist in the data base,

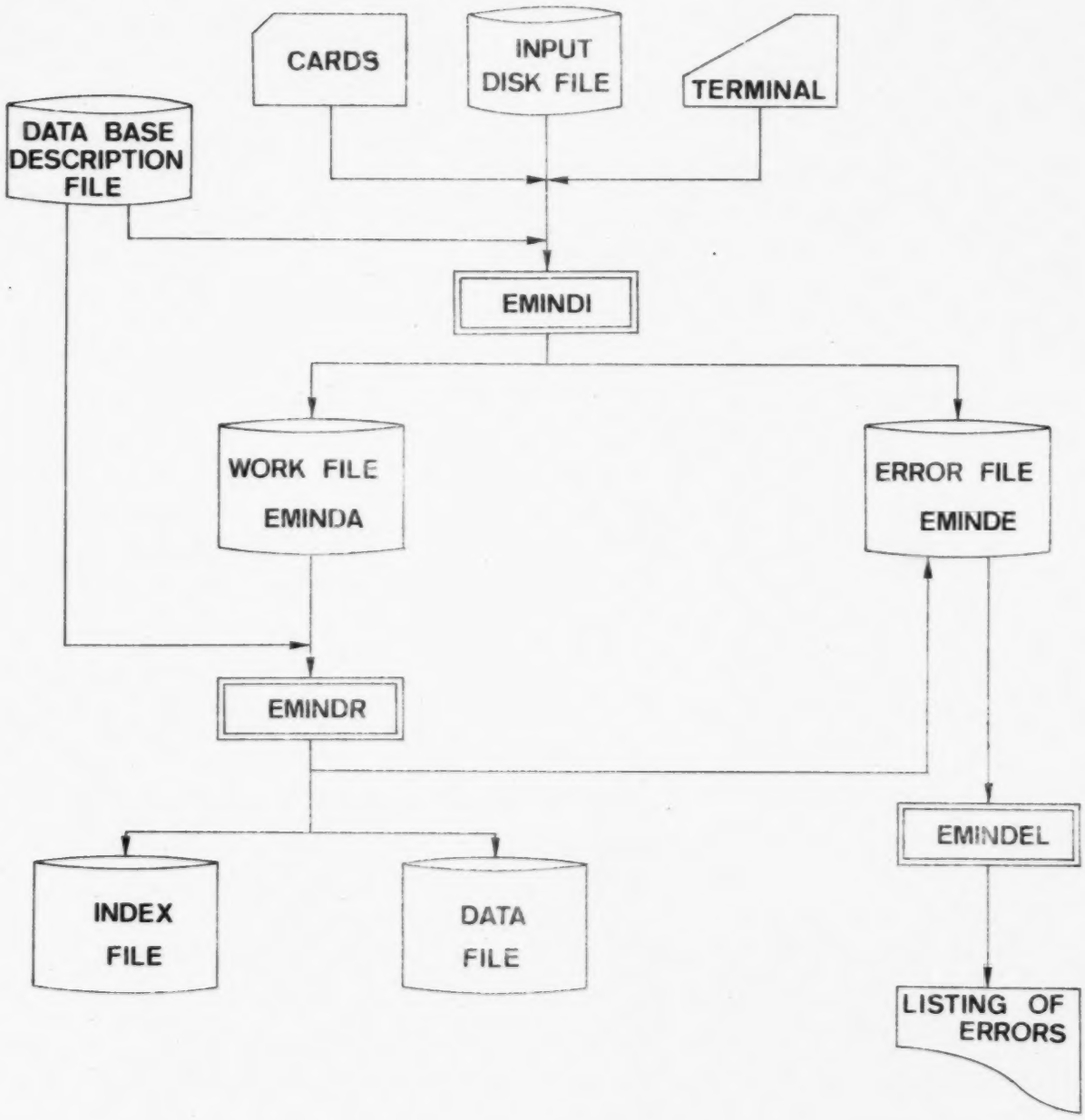

Figure 3 - Schematic data flow chart for updating.

- the routine EMNDEL merely outputs a listing of rejected data ranked by error cause. This listing is consulted by the Data Base Administration in order to correct the errors. When necessary, the listing is sent back to the team responsible for the inventory.

1.4. Editing procedures

At this stage of development, there exist three main routines which produce, under standard format, lists of stored data.

- the routine EMNDLN

  For every plant, this routine prints a listing of all available data, where every coded zone is decoded in order to make the listing more easily readable by the team in charge of the inventory and to allow this team to check the stored information. The listing is sent ultimately to the plant which validates the data. The corrections, if any, are send back to the Data Base Administrator which updates the data base, outputs a new listing and sends it back. This process will stop whenever all the data have been corrected and validated.
  Two versions of EMNDLN exist, a Dutch one and a French one.
  In order to decode the coded zones, a special code identification file containing all the defined codes together with their meaning has been created, and the appropriate software developed to add, modify or suppress a code, and also to search for the meaning of a given code.

- the routine EMNDEM

  One of the major goals of the Air Quality Data Bank is to compute effective emissions of a specified pollutant for a given set of plants. The routine EMNDEM plays this

role and produces for each month of the inventory year a standard list of the mean mass flow, the mean volume flow and the mean temperature of the emissions caused by the facilities, the apparatus or going out through the sources.
Optionally, the computed emissions of each source may be stored on a magnetic tape in order to make them available to the team in charge of air pollution modelling.

- the routine EMNDBR

  This last routine is a utility which produces a listing of raw data as it is stored in the data base, essentially for internal usage by the Data Base Administrator. This listing is obtainable for every plant.

1.5. The retrieval procedure EMNDSL

In order to extract information obeying to well defined selection criteria, a routine named EMNDSL has been set up. It allows, by the use of directives to be introduced from the terminal, to get a listing of the required information. The data may be in coded form or not, and on special demand be saved on magnetic tape for further processing.

Every combination of criteria is possible. In the actual version of the procedure, these criteria are always connected conjunctively but an upper and/or a lower boundary may be specified. The number of simultaneous criteria is actually limited to seven.

2. Emission Data Bases for the Area Sources

2.1. Generalities

The methodology that has been used for recording and storing the emission data of the area sources is quite different from the one which has been developed for industrial emissions. Two data bases have been defined one for space heating emissions, the other for mobile sources emissions. The methods of inventory have been set up by two Research Teams. The information structure we have adopted is based on a 2-level network structure which is derived from the TOTAL system in use at the NDPC computer centre. This system handles two levels named "master entry" and "variable entry". We have added the possiblility to code the zones and decode them using a code identification file.

2.2. Space heating emissions

The space heating emissions data base is made of five master entries (fig. 4). Each source is defined as a 1 km^2 square using the Belgian Lambert Coordinates System which is applicable for the whole country. The inventory is set up for every census sector within every city district located in the inventory zone.

The connection with data at the level of the "Lambert square" is accomplished by means of a particular program using a set of special routines relative to the computation of surfaces and surface intersections. The principle is to spread out on each "Lambert square" the data of each census sector taking into account the intersections between both surfaces. The development of the software is now at its very beginning.

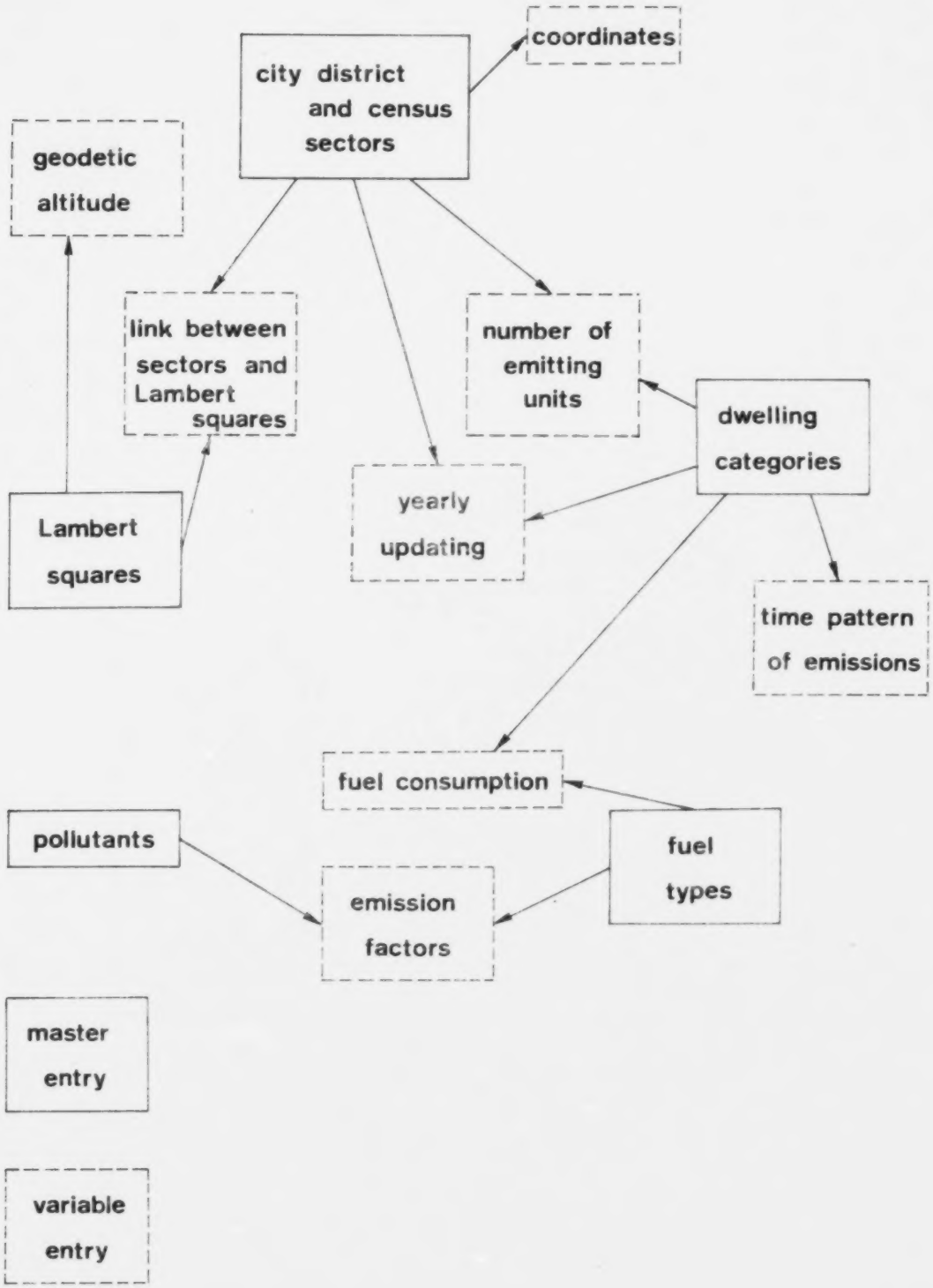

Figure 4 - General structure of the space heating emissions data base.

Nevertheless preliminary reports have already been edited, essentially to check the data transmitted to the Data Bank and to validate the information. The computation routine of effective emissions in the test zone of Gent has now begun in an experimental stage.

Whenever the general software planned is ready, the following routines will be available:

- updating of the data base;
- editing of detailled and summary reports;
- computation of effective emissions;
- query system.

2.3. Mobile sources emissions

The mobile sources emissions data base is constituted with four master entries and eight variable entries (fig. 5).

The inventory is conducted for a certain number of sub-areas in the test zones defined by taking into account the traffic characteristics. Two main categories of traffic have been elaborated, i. e. surface traffic and linear traffic. However both are treated as area sources within the Lambert Coordinates system. The same procedure as for space heating sources has been used to make the link between sub-areas and Lambert squares. The final layout of the data base is not yet absolutely fixed. For example we did not yet study the generalisation to other types of mobile sources, e. g. railway engines, boats and aircraft landing and take off. It may be possible that these kinds of sources should be categorized as linear sources.

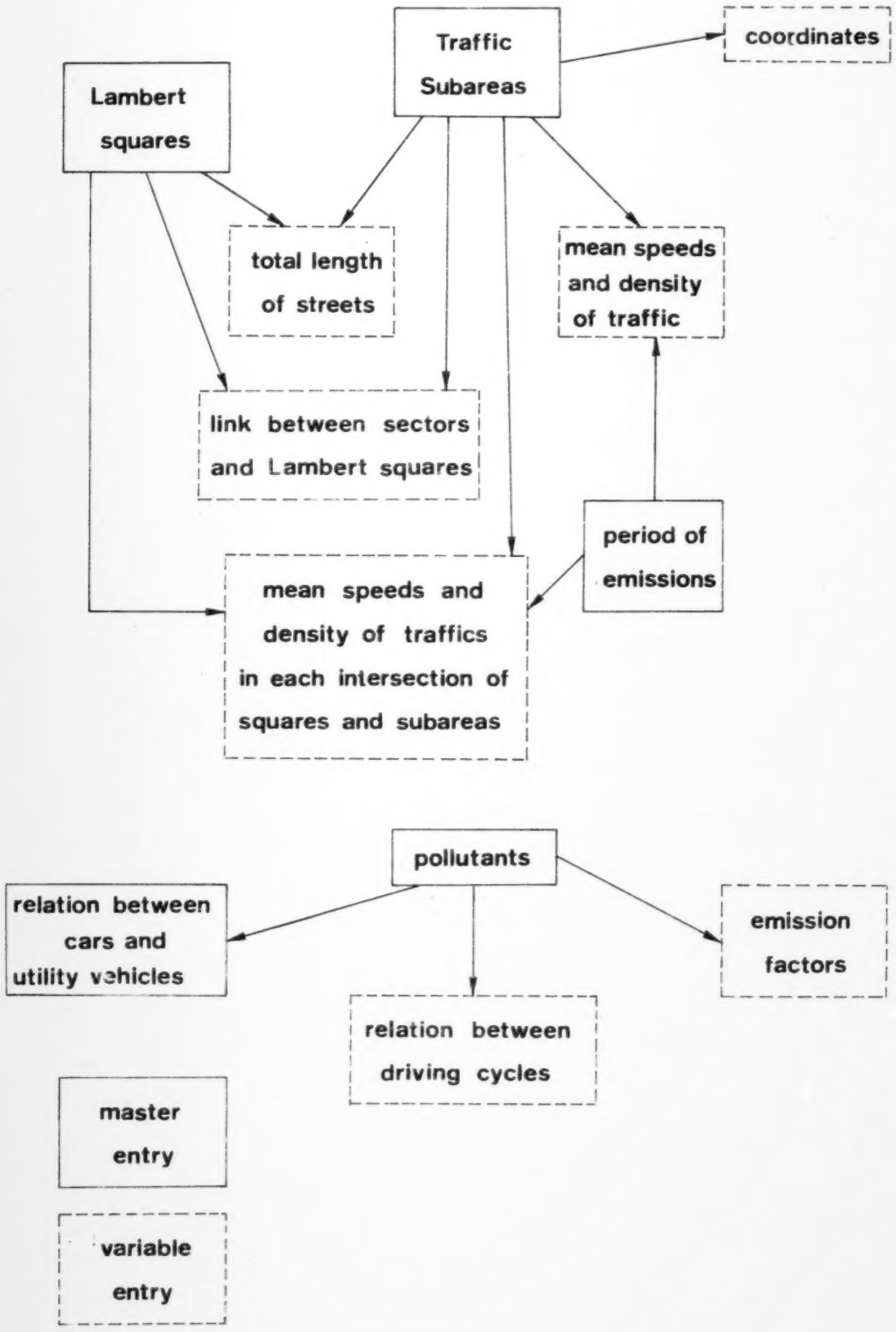

Figure 5 - General structure of the mobile sources emissions data base.

The software development is at its first stage.
We have planned to realize the following basic functions:

- updating of the data base;
- editing of detailed and summary reports;
- computing of effective emissions;
- query routine.

ANNEX I

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ANNEX II

NATO/CCMS Documents on the First Air Pollution Pilot Study (available at: NATO/Committee on the Challenges of Modern Society, NATO Headquarters, Brussels, Belgium)

AIR POLLUTION (No. 5)

Proceedings of the 2nd Meeting of the Expert Panel on Air Pollution Modeling, (26 - 27 July 1971, Paris, France). Out of stock

AIR POLLUTION (No. 6)

Guidelines to Assessment of Air Quality (Revised)

APPENDIX A	Assessment of Air Quality in Ankara (February 1973)
APPENDIX B	Assessment of Air Quality in St. Louis (February 1973)
APPENDIX C	Assessment of Air Quality in Frankfurt (June 1974)
APPENDIX D	Assessment of Air Quality in Oslo (February 1973)
APPENDIX E	Assessment of Air Quality in the South Holland Region (December 1973)

AIR POLLUTION (No. 7)

Quality Criteria for Sulphur Oxides (November 1971). Out of stock

AIR POLLUTION (No. 8)

Air Quality Criteria for Particulate Matter (November 1971). Out of stock

AIR POLLUTION (No. 10)

Air Quality Criteria for Carbon Monoxide (June 1972)

AIR POLLUTION (No. 12)

Control Techniques for Sulphur Oxide Air Pollutants (October 1973)

AIR POLLUTION (No. 13)

Control Techniques for Particulate Air Pollutants (October 1973)

AIR POLLUTION (No. 14)

Proceedings of the 3rd Meeting of the Expert Panel on Air Pollution Modeling
(2 - 3 October, 1972, Paris)

AIR POLLUTION (No. 15)

Air Ouality Criteria for Nitrogen Oxides (June 1973)

AIR POLLUTION (No. 18)

Control Techniques for Carbon Monoxide Emissions from Stationary Sources (October 1973)

AIR POLLUTION (No. 19)

Control Techniques for Hydrocarbon and Organic Solvent Emissions from Stationary Sources (October 1973)

AIR POLLUTION (No. 20)

Control Techniques for Nitrogen Oxide Emissions from Stationary Sources (October 1973)

AIR POLLUTION (No. 29)

Air Quality Criteria for Photochemical Oxidants and Related Hydrocarbons (February 1974)

AIR POLLUTION (No. 30)

Proceedings of the 4th Meeting of the Expert Panel on Air Pollution Modeling, (28 - 30 May 1973, Oberursel, Germany)

AIR POLLUTION (No. 33)

Final Report (May 1974)

AIR POLLUTION (No. 35)

Proceedings of the 5th Meeting of the Expert Panel on Air Pollution Modeling (4 - 6 June 1974, Roskilde, Denmark)

AIR POLLUTION (No. 41)

First Follow-up Report (December 1975)

AIR POLLUTION (No. 50)

Second Follow-up Report (December 1976)

AIR POLLUTION (No. 67)

Third Follow-up Report (November 1977)

AIR POLLUTION (No. 96)

Fourth Follow-up Report (October 1978)

AIR POLLUTION (No. 6, Appendix C revised)

Assessment of Air Quality in Frankfurt (December 1977)

ANNEX III

NATO/CCMS Documents on the Pilot Study on Air Pollution Assessment Methodology and Modeling
(available at: NATO/Committee on the Challenges of Modern Society, NATO Headquarters, Brussels, Belgium)

Air Pollution (No. 42)

Proceedings of the 6th International Technical Meeting on Air Pollution Modeling and its Application
(24 - 26 September 1976, Frankfurt/Main, Germany)

Air Pollution (No. 51)

Proceedings of the 7th International Technical Meeting on Air Pollution Modeling and its Application
(7 - 10 September 1976, Airlie House, USA)

Air Pollution (No. 70)

Bibliography on Grey Literature on Air Quality Modeling, Part I (Applied Models) (October 1977)

Air Pollution (No. 71)

Air Quality Management Systems (AQMS) (October 1977)

Air Pollution (No. 88)

Bibliography on Grey Literature on Air Quality Modeling, Part II (New Modeling Techniques) (October 1978)

Air Pollution (No. 89)

Glossary of Terms Generally Used in Air Pollution Assessment Methodology and Modeling (October 1978)

Air Pollution (No. 80)

Proceedings of the 8th International Technical Meeting on Air Pollution Modeling and its Application
(20 - 23 September 1977, Louvain-la-Neuve, Belgium)

Air Pollution (No. 99)

Introduction to Air Quality Modeling (October 1978)

Air Pollution (No. 100)

Air Pollution Emissions Projecting (October 1978)

Air Pollution (No. 101)

Uses and Needs for Air Quality Modeling (May 1979)

Air Pollution (No. 102)

Fundamentals for the Application of a Gaussian Plume Model
(April 1979)

Air Pollution (No. 104)

Air Pollution Emissions Inventory Systems
(October 1978/July 1979)

APPENDIX A: Emissions Inventory in Belgium
APPENDIX B: Emissions Inventory in Canada
APPENDIX C: Emissions Inventory in Germany, Federal Republic of
APPENDIX D: Emissions Inventory in The Netherlands
APPENDIX E: Emissions Inventory in Norway
APPENDIX F: Emissions Inventory in the United States of America

Air Pollution (No. 106)

Practical Demonstration of Multiple Source Urban Air Quality Modeling (Gaussian Plume) (August 1979)

Air Pollution (No. 71, Revised)

Air Quality Management Systems (AQMS) (April 1979)

Air Pollution (No. 105)

FINAL REPORT (October 1979)

Air Pollution (No. 103)

Proceedings of the 9th International Technical Meeting on Air Pollution Modeling and its Application
(28 - 31 August, 1978, Toronto, Canada)

Air Pollution (No. 108)

Proceedings of the 10th International Technical Meeting on Air Pollution Modeling and its Application
(23 - 26 October, 1979, Roma, Italy)